EP 29297 (22)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 June 2002 (13.06.2002)

PCT

(10) International Publication Number
WO 02/47118 A2

(51) International Patent Classification[7]: H01L

(21) International Application Number: PCT/US01/46538

(22) International Filing Date: 4 December 2001 (04.12.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/251,025 4 December 2000 (04.12.2000) US

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(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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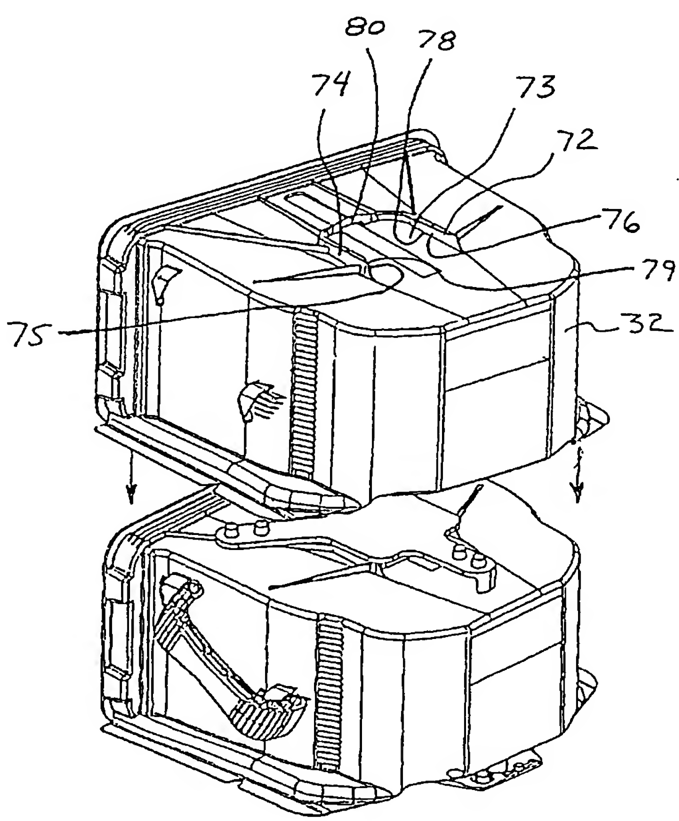
(54) Title: WAFER CARRIER WITH STACKING ADAPTOR PLATE



(57) Abstract: A front opening wafer container has a container portion with a transparent shell and a door to close the open front. The container portion has a machine interface on the bottom of the shell, such as a kinematic coupling, and a receptacle at the top of the shell to receive an accessories, in particular a robotic lifting flange or an adaptor plate. The adaptor plate will ideally have a cooperating machine interface portions to allow stacking of the wafer carriers. The receptacle has, in preferred embodiments, sliding support guides with undercut portions for retention of the robotic lifting flange or the adaptor plate. The accessory will ideally have a detent positioned on the accessories to releasably lock said accessory in place on the container portion.

WO 02/47118 A2

Published:
— *without international search report and to be republished upon receipt of that report*

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WAFER CARRIER WITH STACKING ADAPTOR PLATE

This application claims priority to Provisional Application 60/251,025 with a filing date of December 4, 2000. Said application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

The invention relates to carriers for semiconductor wafers and more particularly it relates to a closeable container for storing and transporting wafers.

Sealable enclosures, generally termed transport modules, have been utilized in the semiconductor processing industry for a number of years for storing and transporting wafers between processing steps and/or between facilities. Semiconductor wafers are notoriously vulnerable to damage from contaminants such as particles. Extraordinary measures are taken to eliminate contaminants in cleanrooms and other environments where semiconductor wafers are stored or processed into circuits.

For wafers in the range of 200 mm and smaller, containers known as SMIF pods (standardized mechanism interface) have been utilized to provide a clean sealed mini-environment. Examples of these pods are shown in U.S. Patent Nos. 4,532,970 and 4,534,389. Such SMIF pods typically utilize a transparent box-shaped shell with a lower door frame or flange defining an open bottom and a latchable door. The door frame clamps onto processing equipment and a door on the processing equipment and the lower SMIF pod door closing the open bottom are simultaneously lowered downwardly from the shell into a sealed processing environment in said processing equipment. A separate H-bar carrier positioned on the top surface inside of the SMIF pod door and loaded with wafers is lowered with the pod door for accessing and processing said wafers. In such pods the weight of the wafers would be directly on the door during storage and transport.

The semiconductor processing industry is moving toward utilization of larger and heavier wafers, specifically 30 mm wafers. Transport modules for such modules, utilize a front opening door for insertion and removal of the wafers as opposed to a bottom door that

drops downwardly from the module. The door would not support the load of the wafers, rather a container portion which would include a clear plastic (such as polycarbonate) shell and other members for supporting the wafers molded from a low particle generating plastic (such as polyetheretberketone) would carry the load of the wafers. Such container portions necessarily are made from multiple components assembled together.

Industry standards for such 300 mm modules require a machine interface, such as a kinematic coupling, on the bottom of the module to repeatedly and with precision align the module with respect to the processing equipment. This allows robotic handling means to engage the door on the front side of the module, open the door, and with the necessary amount of precision grasp and remove specific horizontally arranged wafers. It is highly critical to have the wafers positioned at a particular height and orientation with reference to the equipment machine interface such that the wafers will not be located and damaged during the robotic withdrawal and insertion of said wafers.

The 300 mm wafers are substantially greater in size and weight than the 200 mm modules; therefore, a structurally stronger module for transporting batches of wafers is required. Typically with the 200 mm SMIF pods the module was simply carried manually by grasping the lower edges at the juncture of the shell door flange and the door. Handles have been provided on the top of the shell portion for bottom opening pods. For carrying the larger, heavier, and bulkier modules for 300 mm wafers side handles are appropriate. For certain application, the movement of the 300 mm module may be exclusively by way of robotic means. Such robotic means is accomplished by a lifting flange on the top surface of the top of the carrier.

During processing, storage, or shipping it is beneficial to assemble as many wafer containers together as possible in a given area. Particularly in a fab where space is at a premium, stacking of wafer containers, loaded or unloaded, can save space and provide ready access to multiple containers of wafers. Generally, the more wafer containers that can be stored in a given area, the better.

The machine interfaces on the bottom of 300 mm wafer containers provide a very stable positioning mechanism when the container is interfacing with process equipment

equipped with a kinematic coupling. However, hereto before, stacking of such wafer containers on top of one another was fraught with hazard and generally such wafer carriers simply would not stack. A means for facilitating the stable stacking of wafer carriers in the minimal amount of space is needed.

Additionally, the use at any location in the pod of metallic fasteners or other metal parts is highly undesirable in semiconductor wafer carriers or containers. Metallic parts generate highly damaging particulates when rubbed or scraped. Assembly of a module with fasteners causes such rubbing and scraping. Thus, the use of transport modules requiring metal fasteners or other metal parts is to be avoided. Thus stacking means utilizing metal fasteners are to be avoided.

SUMMARY OF THE INVENTION

A front opening wafer container has a container portion with a transparent shell and a door to close the open front. The container portion has a machine interface on the bottom of the shell, such as a kinematic coupling, and will typically have a receptacle at the top of the shell to receive an accessory such as a robotic lifting flange. The adaptor plate will ideally have cooperating machine interface portions to allow stacking of the wafer carriers. The receptacle has, in preferred embodiments, sliding support guides with undercut portions for retention of the robotic lifting flange or the adaptor plate . The accessory will ideally have a detent positioned on the accessory to releaseably lock said accessory in place on the container portion.

A feature and advantage of the invention is that the wafer containers may have the conventional robotic handling features and also have the capability of being securely stacked. The stacking adaptor plate is removeably placed on or secured to the container portion to provide a secure seat for the machine interface of a wafer container to be stacked thereon. Several wafer containers may be stacked together saving fab space.

A further feature and advantage of particular embodiments of the invention is that the stacking adaptor plate provides three points of contact with the upper wafer container that the adaptor plate supports and three points of contact with the lower wafer carrier that supports the adaptor plate.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a prior art wafer carrier with a robotic flange attached to the top of the container portion.

FIG. 2 is a perspective view of a wafer carrier with a kinematic coupling machine interface with a cooperating stacking adapter displaced therefrom.

FIG. 3 is a elevational of a stacking adaptor.

FIG. 4 is a perspective view of the stacking adaptor of FIG. 3

FIG. 5 is a perspective view of the stacking adaptor of FIG. 3 and FIG. 4.

FIG. 6 is a perspective view of a pair of wafer carrier being stacked in accordance with the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Such machine interfaces FIG. 1 illustrates a prior art wafer container 30. Such a carrier includes a container portion 32, a door 34, and a robotic flange 36, and manual handles 44. Such wafer carriers have a plurality of horizontal wafer slots formed by plurality of pairs of wafer shelves positioned in the container portions. FIG. 2 shows another style of wafer container, similarly having the container portion 32, handles 44, and also illustrating a machine interface 48 configured in a first configuration as a kinematic coupling. The kinematic coupling has three grooves 49 such as are illustrated in U.S. Patent Nos. 5,755,332; 5,944,194; 6,010,008; and 6,010,009. These patents are all incorporated herein by reference. Kinematic couplings have proven to be an effective machine interface and are the industry standard for 300 mm wafer carriers. The kinematic coupling machine interfaces have cooperating portions, one portion has three projections, such as partial spheres, positioned at the three points of an equilateral triangle, and the other portion has three grooves that receive the partial spheres to repeatably and accurately seat the two portions together. Such a kinematic coupling portion may be separately formed, such as by injection molding, and suitably attached to the bottom of a container portion. Such a portion is illustrated in U.S. Patent No. 6,216,874, commonly owned with the instant application. Said patent is hereby incorporated by reference. Alternatively, the machine interface may be an integral part of the container portion or may be part of the structural framework as disclosed in U.S. Patent No. 6,010,008. A stacking adaptor 50 is illustrated in position to engage with the kinematic coupling in FIG. 2.

FIGS. 3, 4, and 5 illustrates a preferred embodiment of a stacking adaptor. The plate has a body portion 54 with a top side 55 having kinematic coupling portion 56, and a bottom side 58 having an attachment portion 59. The kinematic coupling portion comprises at least three rounded projections 60, and as illustrated, has an addition set of three supplemental projections 62. Three legs 63 extend horizontally and each leg has at least one of the at least three projections. The projections may be separately formed and attached with suitable fasteners 68, or may be integrally molded with the body portion. The bottom side 58 includes

three wafer carrier contact portions 66 that are placed proximate to the kinematic coupling projections on the top side. Additionally, a contact portion 70 is configured to correspond with the base of a robotic flange to cooperatively engage with the top of a wafer carrier in place of the robotic flange. The adaptor also has a hook shaped member 71 that functions as a detent.

FIG. 6 illustrates the receptacle portion 73 of a container portion 32 that receives accessories such as the robotic lifting flange or the stacking adaptor plate. The receptacle portion may have a pair of sliding guide members 72, 74 that have an undercut portions 75, 76 that define slots 78, 79. The undercut may be at an angle to the horizontal to allow the accessory to wedge into position providing further securement of same on the container portion. Also a latching portion 80 may receive a detent on the accessories to releaseably secure the accessory at the receptacle portion. FIG. 6 also illustrates a pair of wafer carriers in the process of being stacked on top of one another utilizing a stacking adaptor in accordance with the invention.

Referring to FIG. 4 two wedge members 88,90 cooperate with the slots 78, 79 on the receptacle portion. The attachment portion for the kinematic coupling stacking adaptor plate can have an attachment portion configured the same as the robotic flange's attachment portion as shown. The robotic flange and stacking adaptor plate may be suitably formed by injection molding thermoplastics such as carbon fiber or carbon filled polycarbonate. Other plastics may be utilized and other materials such as metal may also be appropriate. For carbon filled plastic, the carbon provides a desirable static dissipative characteristic. The stacking adaptor plate may be conductively connected to the kinematic coupling of the container portion onto which the adaptor plate is attached for creating a conductive path through the stack of wafer carriers.

In an alternative embodiment, the robotic flange may remain in place and the stacking adaptor plate may be configured to cooperate and preferably attach directly to said robotic

flange. In other embodiments the stacking adaptor may fit on the top of the container portion around or covering the robotic flange. In wafer carriers that have no receptacle or robotic flange, particular embodiments of the stacking adaptor may engage other available top structure on the wafer carrier. In particular embodiments the stacking adaptor may be permanently affixed to or integral with the top of a wafer carrier. In certain embodiments the stacking adaptor plate may fit on open wafer carriers such as is shown in U.S. Patent Nos. 6,010,009 or the like.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof; and it is, therefore, desired that the present embodiment be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.

WHAT IS CLAIMED IS:

1. A wafer container system comprising:

a) a container portion with an open front, a top, and a bottom;

b) a door for closing the open front;

c) a machine interface on the bottom of the container portion, the machine interface having a first configuration;

d) a receptacle portion on the top of the container portion; and

e) a stacking adaptor plate for engagement with the container portion at the receptacle portion, the stacking adaptor configured to cooperate with a machine interface with the first configuration.

2. The wafer container system of claim one wherein the stacking adaptor plate has at least three rounded projections and a detent for latching onto the container portion at the receptacle portion.

3. The wafer container system of claim 1, wherein the stacking adaptor plate has three container portion contact portions extending downwardly and positioned proximate the at least three rounded projections.

4. A stacking adaptor plate for stacking a plurality of wafer containers, the containers each having a top, and a bottom with a kinematic coupling thereon, the stacking adaptor plate adapted to fit on the top of the wafer container to facilitate stacking of the plurality of wafer containers and having an upwardly facing kinematic coupling portion.

5. The stacking adaptor plate of claim 4 wherein the adaptor plate has a detent for removably attaching the plate to wafer containers.

6. A wafer container system comprising a container portion having a plurality of slots therein for holding a plurality of wafers, the container portion further comprising a top, a bottom, a machine interface positioned at the bottom, and an adaptor plate conformed to engage with the top of the wafer container, the adaptor plate comprising at least three rounded projections comprising one portion of a kinematic coupling.

7. The stacking adaptor plate of claim 4 wherein the adaptor plate has a detent for removably attaching the plate to wafer containers.

8. The stacking adaptor plate of claim 6 wherein the plate further comprises three legs extending horizontally and spaced equally from one another.

9. The stacking adaptor plate of claim 6 wherein the plate has three legs extending horizontally with one leg at each of having one of the at least three rounded projections.

10. A wafer container system comprising a container portion having a plurality of slots therein for holding a plurality of wafers, the container portion further comprising a top, a bottom, a machine interface positioned at the bottom, and a stacking adaptor at the top of the wafer container, the machine interface comprising three grooves as one part of a kinematic coupling the adaptor plate comprising at least three rounded projections comprising the cooperating part of a kinematic coupling, whereby a plurality of said wafer containers may be stacked together with two parts of kinematic coupling intermediate each adjacent pair.

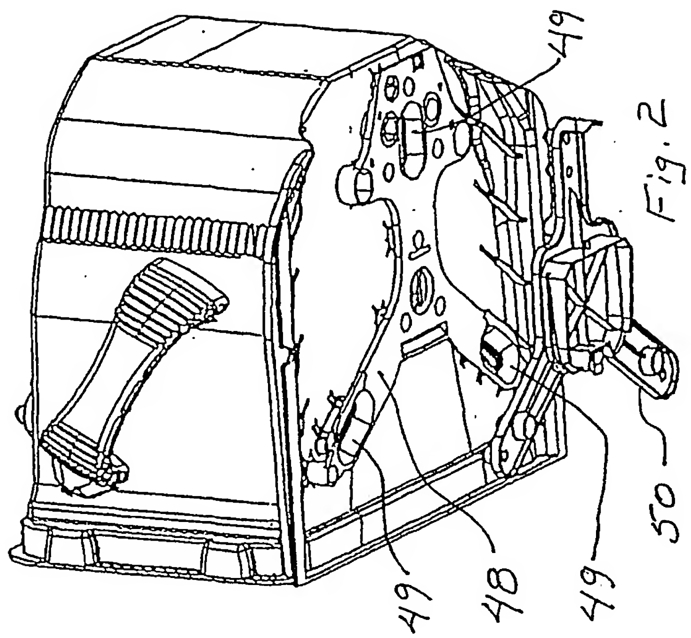

Fig. 2

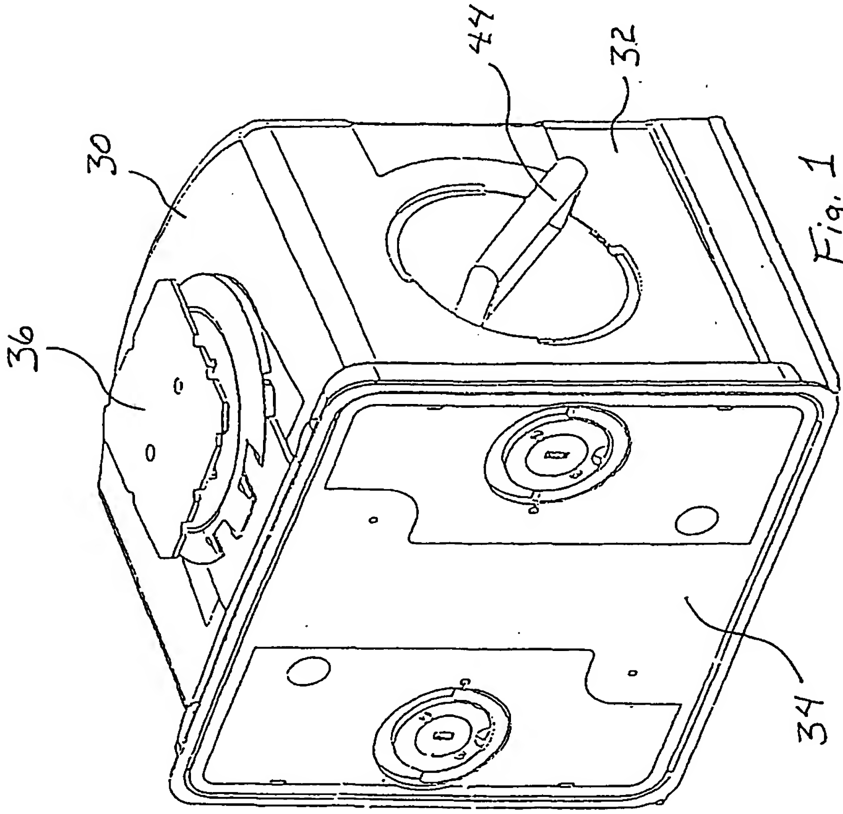

Fig. 1

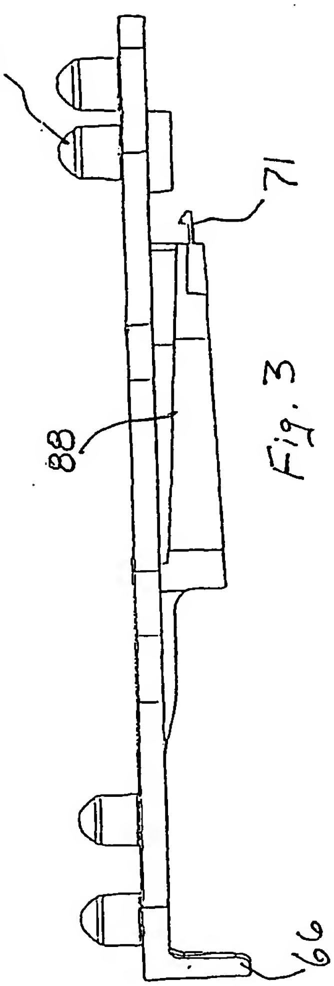

Fig. 3

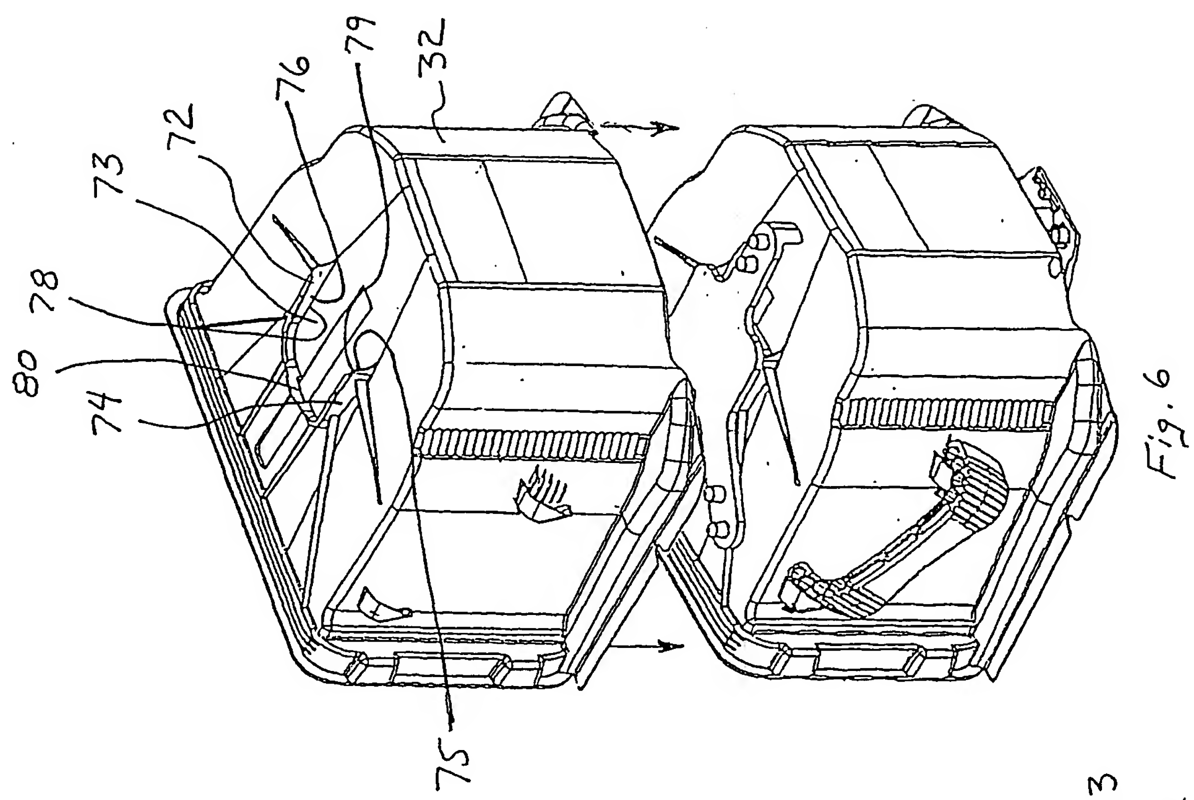

Fig. 6

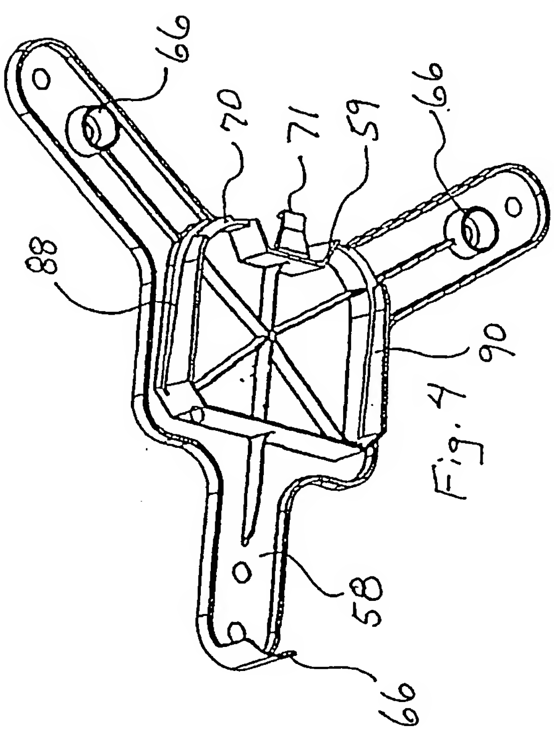

Fig. 4

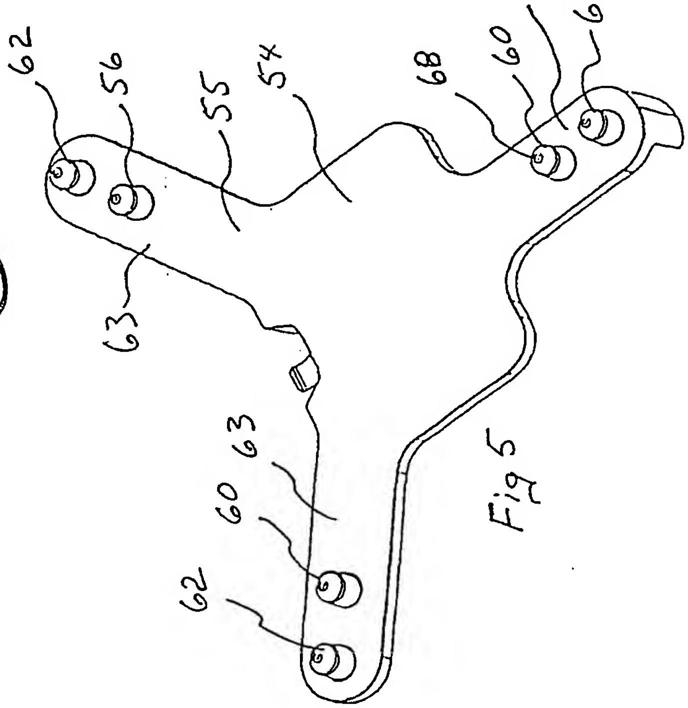

Fig 5